Art. I.—*Notes on the Eocene Strata of the Bellarine Peninsula with brief references to other deposits.*

(With Plate I.)

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Our chief inducement for visiting the Bellarine Peninsula was the object of settling on palæontological evidence whether the small outcrop marked on the maps ($\frac{1}{4}$ sheet 23 S.W.) belongs to eocene or to miocene age, the two sets of beds having been elsewhere confused. Certain peculiarities of the deposits however induced us to extend our observations to other portions of the district where similar beds are exposed.

The Peninsula consists of a central mass of the Jurassic freshwater series, an outlying portion of the Barrabool and Otway beds. Overlying these beds in their northern area occurs the Older Basalt, affording by its decomposition the rich soil for which that part of the district is so well known. Surrounding this central mass is a ring of marine eocene beds. Exposures of the latter occur on the northern and southern boundaries whereever the natural conditions afford an opportunity of seeing them. On the eastern and western sides no exposures are to be seen as the thick mantle of upper tertiary beds covers the slopes and flats and hides the underlying series from view. There is little doubt however that the ring is complete, as to the westward the Geelong eocenes, as represented by the Corio Bay, Moorabool Valley and Belmont beds are well developed, while to the eastward the Mornington beds occur just across the bay, and as Mr. Daintree reports* similiar beds were passed through in the Queenscliff bore.

The jurassic rocks, although occuping such a large extent of the peninsula, show only one small outcrop just to the westward of Portarlington.† A syncline occurs between the Bellarine beds

* Parl. Rep., 1861-62, A 43. † $\frac{1}{4}$ Sheet 23 N.E. Note.

and those of the Barrabools, the latter dipping easterly and showing in a series of outcrops the beds proved in the Bellarine bores.*

The Older Volcanic.

Along the cliffs at Portarlington the older volcanic rock occurs on both sides of the pier and exhibits various degrees of decomposition. In one place it is quarried for road metal, while to the east it is a soft unctuous clay which can be traced along the cliffs gradually showing more and more its true character till it disappears below sea level. In this locality it is overlain by coarse ferruginous grits which are probably of upper tertiary age. Near the Clifton Springs it forms the greater part of the cliffs. Here, at about thirty feet above sea level, it is covered by a conglomerate consisting of sub-angular and well rounded pebbles up to four or five inches in diameter, and comprising quartz in various forms, hard blue metamorphic sandstones, nodular schists, and other altered argillaceous rocks with beds of sand and clay. Towards the top it gradually becomes finer and more sandy. At the Drysdale Pier hard ferruginous grits come down to the water's edge, the volcanic rock having been here, as elsewhere, deeply denuded. At the next point, about a quarter of a mile west of the pier, the beach floor and cliffs consist of a volcanic ash or breccia, full of angular fragments of scoriaceous basalt up to an inch in diameter. The deposit is well and evenly bedded and has a dip some degrees west of north at about 20°. Decomposition has considerably affected the strata and the colours are very variable, being blue, gray, dark-green, fawn and chocolate. From here, for about 2½ miles westward, these ash beds are almost continuously exposed to view on the beach floor with intermissions to be mentioned presently. In some places the cliffs are seen to be almost entirely composed of ash overlain by a variable thickness of upper tertiary clays and grits. The ash beds gradually sink to sea level and disappear near the boundary between the parishes of Bellarine and Moolap, where they are overlain by eocene beds. These continue for nearly half a mile, when ash beds again appear from beneath them with a north-easterly dip. We roughly estimated a thickness of 300 feet of

* ¼ Sheet 24 S.E. Note 7.

ash to be exposed here. At the place marked Ad 12 on the $\frac{1}{4}$ Sheet, which is the most prominent point between Clifton and Point Henry, a dyke of fine, dense basalt occurs in the ash. The included fragments in the ash beds here are of larger size, some being upwards of two feet in diameter, and consist principally of masses of basalt, though a few embedded blocks of brownish sandstone, and of an altered yellow argillaceous rock were visible. The latter are probably derived from the underlying mesozoic rocks, though considerably altered in appearance and hardness, they at any rate do not resemble any of our Silurian rocks. From the size of the ejected masses, and from the presence of the dyke, it is probable that we are here close to a vent of the Older Volcanic rock, the greater part of the core having been removed by denudation. Overlying the ash at this point and on its eroded surface occurs a sheet of polyzoal rock. That it does not consist of ejected fragments is clear from its well bedded structure and from its constant dip. It occurs in large tabular masses and is nowhere seen overlain by the volcanic rock. It has for the most part been removed on the higher parts of the beach, where loose blocks of it occur; but at low-tide it may be seen to form a fairly continuous sheet passing out under water to the north. In most places it is altered to a crystalline reddish rock, the weathered surfaces of which are crowded with fossils standing up in relief, and the usual cream colour, which characterises the rock in other localities, prevails. The fossils are principally polyzoa though brachiopods, lamellibranchs and gastropods occur. Similar rock occurs at Sutherland's Creek, near Maude, and again in the Moorabool Valley,* and is at the latter place not associated with igneous rock. At the parish boundary, (Locality 1) where we first noted the eocene beds, the dip of the ash beds and of the former is approximately to the north-west and the volcanic series can be seen passing beneath the fossiliferous strata. So that in these two places we have evidence, that here, the older volcanic rocks are antecedent to the eocene series, and not overlying them as indicated in Daintree's report on the district† and by the colouring and lettering on $\frac{1}{4}$ sheets 23 S.E. and 23 S.W.

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* Proc. Roy. Soc. Vic., vol. iv, N.S., p. 11. † Parl. Report, 1861-62, A 43.

In the ¼ sheets (23 S.W. and 23 S.E.) dealing with this portion of the district, some confusion exists as to the volcanic rocks. The large outcrop forming the Bellarine Hills is marked as older volcanic, of which it is regarded as forming a typical locality. On the west side of the road from Portarlington to Drysdale, the lettering in the two places indicates newer pliocene overlying older volcanic in one case close to the cliff, while the cliff section shows an outcrop coloured to represent lower volcanic ('pliocene'), but not lettered. On ¼ sheet 23 S.W. the same outcrop is shown running along past Clifton Springs, with one intermission, to a short distance past the dyke we have alluded to. This intermission should not occur, as the ash beds crop out continuously along the beach at this place. Both these separated portions of the same outcrop are marked V. 1, 2, 3, that is, as the legend shows, lower volcanic ('pliocene') basalt dolerite, anamesite and lava, while V. 4 (ash, conglomerate, &c.) is omitted, although a section of over two miles in length is exposed. This is not all, for a note near the parish boundary and close to the volcanic outcrop states that "the basalt outcrop of the Bellarine Hills probably underlies the pliocene tertiary sands and ironstones as far south as the heads of the creeks falling into Corio Bay." So that this outcrop is coloured 'pliocene' and alluded to as 'miocene;' while the true state of the case is that it is unconformably overlain by the clays which were then called miocene or oligocene but which are now regarded as eocene.

The Curlewis Eocenes.

This will be a convenient name for this section, as the hamlet of Curlewis is situated on the Portarlington Road, about a mile to the southward.

It is probable, as will presently appear, that the sequence of eocene beds here is similar to what occurs in the Moorabool Valley,* that is, that the polyzoal rock, where it occurs, is the underlying member of the series, though we were unable to absolutely prove the succession.

At the first place where we noted the eocene beds (parish boundary), they consisted of blue clays resting on ash beds, the

* Proc. Roy. Soc. Vic., vol. iv., N.S., pp. 9 et seq.

dip of both deposits being to the seaward. This dip is the most marked peculiarity of the beds in this locality. There occurs a band of about six feet in thickness of marked character which can be traced, with but few intermissions, for two miles along the coast. Its upper portion consists of about three feet of dark-brown earthy limestone, very sandy, and containing casts of fossils; below this, is about 18 inches of gray clay and then about the same thickness of a rock similar to the upper band, but more easily weathered and of a lighter hue. Both above and below this band, occur stiff blue clays similar to those of Mornington, Spring Creek and the Gellibrand. The angle of dip averages about 25°. In some places it is as low as 10° and near the western end of the section for about 30 yards it dips at 45°. Dipping as the beds do, this hard band stands out from the softer clays like a wall, usually from two to three feet above the almost level floor of the beach. The beds as shown by this band are contorted and faulted. At the parish boundary, we can on ascending the low cliff, see the band coming in to the shore from the north-east and winding with a serpentine curvature. It sweeps round the point in one curve, the dip swinging through an arc of 90°, from a few degrees east of north to a few degrees north of west. Numerous small faults occur, trending north-west, the throw being usually a few inches and rarely exceeding a foot, and the hade nearly vertical. In one place we counted six faults in about 50 yards Along this outcrop the easterly beds are shifted to the north, or in other words, the downthrow is to the south-west. We thus have displayed a beautiful series of step faults. In one place on the curve however, the band between two faults has gone out into deep water, and although the tide was low we could not find any trace of the band *in situ*. Actual measurement showed a lateral displacement of over 30 feet while the loose blocks in the water, which stopped further measurement, showed the direction in which displacement had taken place.

The clay above and below the band is full of nodules of iron pyrites. In places slight hollows on the beach are full of loose pieces washed out, and covered with a crust of limonite. Occasionally, below the band the pyrites has oxidized *in situ*, and has stained the clay yellow. This decomposition is however more frequent in the clay overlying the band and the general tint is consequently of a lighter hue.

Blocks of the earthy limestone band occur on the beach at this point, above high-water mark, and lithologically closely resemble eocene rocks forming the cliffs on the western shores of Corio Bay. From these blocks we procured the following fossils:

Dimya dissimilis, Tate.
Pecten Yahlensis, T. Woods.
Spondylus pseudoradula, McCoy.
Waldheimia divaricata, Tate.
Polyzoa.
Echini spines.

The clays of this place (Locality 1) however, yielded a far greater number of forms, as shown by the following list, which is the result of but a few hours work.

List of Fossils from Locality 1.

Class, Zoantharia.

Placotrochus deltoideus, Duncan.
Flabellum Victoriæ, Duncan.
Conosmilia anomala, Duncan.

Class, Echinodermata.

Cidaroid spines.

Class, Polyzoa.

Numerous genera and species.

Class, Palliobranchiata.

Terebratulina Scoulari, Tate.

Class, Lamellibranchiata.

Pecten dichotomalis, Tate.
,, Foulcheri, T. Woods.
,, (Amussium) Zitteli, Hutton.
Lima Bassii, T. Woods.
Limea transenna, Tate.
Modiolaria singularis, Tate.
Crenella n. sp. aff. globularis.
Nucula tumida, T. Woods.
,, Atkinsoni, Johnston.
Leda Huttoni, T. Woods.
,, apiculata, Tate.
,, obolella, Tate.

Pectunculus laticostatus, Quoy and Gaimard.
Macrodon Cainozoicus, Tate.
Cucullæa Corioensis, McCoy.
Cardita sp.
Chama lamellifera, T. Woods.
Chione? n. sp.
Myadora tenuilirata, Tate.

Class, Gastropoda.

Ranella Prattii, T. Woods.
Triton tortirostris, Tate.
Fusus craspedotus, Tate.
Peristernia lintea, Tate.
„ sp.
Zemira præcursoria, Tate.
Voluta antiscalaris, McCoy.
„ McCoyii, T. Woods.
„ n. sp. = Spring Creek.
„ (Volutoconus) n. sp. aff. conoidea.
Lyria harpularia, Tate.
Mitra atractoides, Tate.
Marginella propinqua, Tate.
„ sub-Wentworthi, Tate.
„ micula, Tate.
„ sp.
Ancillaria hebera, Hutton.
„ pseudaustralis, Tate.
Columbella clathrata, Tate, m.s.
„ sp.
Cancellaria Etheridgei, Johnston.
„ n. sp.
Pleurotoma sp.
Drillia sp.
Mangilia sp.
? „ sp.
Raphitoma n. sp.
Pusianella aff. hemiothone.
„ n. sp.
Conus heterospira, Tate.
Cypræa brachypyga, Tate.

Semicassis transenna, Tate.
Cassidaria gradata, Tate.
Natica Hamiltonensis, T. Woods.
Crepidula sp.
? Scalaria sp.
Turritella Murrayana, Tate.
 ,, sp.
 ,, sp.
Vermetus sp.
Niso psila, T. Woods.
Cerithiopsis n. sp.
Delphinula aster, T. Woods.
Scaphander fragilis, Tate, m.s.
Ringicula sp.
Cylichna exigua, T. Woods.

Class, Scaphopoda.

Entalis Mantelli, Zittel.
 ,, subfissura, Tate.

Class, Pisces.

Otoliths.

SUMMARY FOR LOCALITY 1.

Class.	No. of Species.
Zoantharia - - - -	3
Palliobranchiata - - -	1
Lamellibranchiata - - -	19
Gastropoda - - - -	46
Scaphopoda - - - -	2
Pisces - - - - -	1
Total - - - -	72

At the point where the polyzoal rock occurs, and on the west side of the gully two intersecting faults, trending N.E. and N., are distinctly traceable on the beach, as they have lowered the eocene blue clay into the ash beds. Each of these faults is visible for several yards, as the clay, being softer than the volcanic rock at this point, has been removed by the waves to about a foot below the level of the latter. A third fault, completing the triangle and having the N.W. trend of all the other faults observed, probably occurs to the westward, but was not visible. The position of the clay beds here, lends force to the view already stated that the polyzoal rock underlies the clay, as close at hand the limestone is seen *in situ* in contact with the volcanic rock; while the downthrow of a fault has been necessary to bring the clay to its level.

About two hundred yards west of this point (Locality 2 on plan) we again find the band, described above, making its appearance, and being traceable for nearly half-a-mile along the shore before disappearing beneath the upper tertiary beds to the west. At the former place where we described it, it has a northerly dip and the lowest beds are on the landward side. Here however, the dip is reversed and the lower beds are to the seaward, a syncline running N.E. and S.W. The strata can be fairly termed contorted. A system of faults with a north-westerly trend is again developed, with the same average throw. Our time did not allow us to work out the directions of the downthrow, the matter being complicated by the contortion of the strata.

To show the way in which contortion has taken place a few examples may be given. At one place the band dips W.—S.—E. at 10°, the radius of curvature of the outcrop being about 20 feet and the upper beds being inside the curve. Then the western end of the band curves round, dipping S.E.—S.—S.W. at 25°, the radius of curvature being 30 feet and the upper beds being on the outside of the curve. The band is curved three or four times in a similar manner to the westward of this point within a distance of a few hundred yards, and it is at this end of the section that we noted the dip as 45° for 30 feet of strike.

Although the beds are so much disturbed the number of crushed shells does not seem greater than usual. Even close to the faults, large shells were perfect. Some specimens which were in contact with pyrites nodules were crushed, but for the most part the fossils were beautifully preserved. From the earthy limestone band of this locality (2) we gathered the following forms:—

Waldheimia divaricata, Tate.
,, insolita, Tate.

Dimya dissimilis, Tate.
Pecten Foulcheri, T. Woods.
Chione Cainozoica (?), T. Woods.
Leda sp. (cast).
Pectunculus laticostatus, Quoy and Gaimard.
Cypraea leptorhyncha, McCoy.

As before, however, the clay beds were the most prolific in fossils, and we give a list of the species gathered, together with references showing their occurrence in some other localities. In this table, the forms gathered at Locality 1 but which were not obtained at Locality 2 are marked with the sign †.

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Class, Rhizopoda.				
Order, Foraminifera.				
Biloculina sp. - - - -	-	X	-	X
? Miliolina sp. - - - -	-	X	X	X
? Orbitolites sp. - - - -	-	-	-	X
Other genera and species - -	-	X	X	X
Class, Actinozoa.				
Order, Zoantharia.				
Flabellum Victoriæ, Duncan -	X	X	X	X
Placotrochus deltoideus, Duncan -	X	X	X	X
Conosmilia anomala, Duncan - -	X	X	X	X
Class, Echinodermata.				
Lovenia Forbesi, Duncan - -	-	-	X	-
† Cidaroid spines - - -	X	X	-	X
Class, Polyzoa.				
Numerous genera and species -	-	X	X	X
Class, Palliobranchiata.				
Waldheimia divaricata, Tate - -	-	-	-	-
† Terebratulina Scoulari, Tate - -	-	X	X	X
Class, Lamellibranchiata.				
Ostræa ? n.sp.	-	-	-	-
Dimya dissimilis, Tate - -	X	X	X	X
Pecten dichotomalis, Tate - -	-	X	-	-
,, Yahlensis, T. Woods - -	-	X	X	X
,, Foulcheri, T. Woods - -	X	X	X	X
† ,, (Amussium) Zitteli, Hutton -	X	X	X	X
Lima Bassii, T. Woods - -	X	X	-	X
† Limea transenna, Tate - -	-	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Spondylus pseudoradula, McCoy -	-	X	-	X
Septifer fenestratus, Tate - -	X	X	-	X
† Modiolaria singularis, Tate - -	-	X	-	X
† Crenella n.sp. aff. globularis - -	-	-	-	-
Nucula tumida, T. Woods - -	-	X	X	X
,, Atkinsoni, Johnston - -	-	X	-	X
,, Morundiana, Tate - -	X	-	X	X
† Leda obolella, Tate - - -	-	X	-	X
,, Huttoni, T. Woods - -	X	X	X	X
,, apiculata, Tate - - -	X	X	? X	X
,, praelonga, Tate - - -	-	X	-	X
Limopsis Belcheri, Adams and Reeve	X	X	X	X
Pectunculus laticostatus, Quoy and Gaimard - - - -	X	X	X	X
Macrodon Cainozoicus, Tate - -	X	X	X	X
Cucullæa Corioensis, McCoy - -	X	X	X	X
Crassatella astartiformis, Tate -	X	X	X	X
Cardita polynema, Tate - -	? X	X	X	-
,, delicatula, Tate - -	X	X	X	X
Chama lamellifera, T. Woods - -	X	X	X	X
Chione Cainozoica ? T. Woods -	-	X	X	X
† ,, ? n.sp. - - - -	-	-	-	-
† Myadora tenuilirata, Tate - -	-	X	X	X
,, n.sp. - - - -	-	-	-	-
Corbula ephamilla, Tate - -	X	X	X	X
,, pixidata, Tate - -	X	X	X	-
Class, Gastropoda.				
Murex velificus, Tate - - -	X	X	X	X
,, rhysus, Tate - - -	-	X	-	X
,, Dennanti, Tate - -	-	-	-	X
,, Eyrei, T. Woods - -	X	X	X	X
,, n.sp. - - - - -	-	-	-	-
Typhis acanthopterus, Tate - -	X	X	-	-
Rapana aculeata, Tate - -	X	X	? X	X
Ranella Prattii, T. Woods - -	X	X	-	X
Triton cyphus, Tate - - -	-	X	-	X
,, Woodsii, Tate - - -	X	X	X	X
,, tortirostris, Tate - -	X	X	X	X
,, gemmulatus, Tate - -	X	X	-	X
Fusus acanthostephes, Tate - -	X	X	X	X
,, craspedotus, Tate - -	X	X	-	X
,, dictyotis, Tate - - -	-	X	-	X
,, n.sp. - - - -	X	-	-	-
,, n.sp. - - - -	-	X	-	-
Latirofusus aciformis, Tate - -	-	X	-	X
Siphonalia longirostris, Tate - -	X	X	-	X
,, n.sp. aff. longirostris -	-	-	-	-
Fasciolaria decipiens, Tate - -	X	-	-	X
Peristernia Morundiana, Tate -	-	-	-	-
,, lintea, Tate - -	-	-	-	X

	Fossils from Curlewis.	Belmont.	Selmapper Point.	Spring Creek.	Muddy Creek.
	Peristernia n.sp.	-	-	-	-
	,, n.sp. aff. crassilabrum	? X	-	-	-
	Dennantia Ino, T. Woods	X	X	-	X
	Zemira præcursoria, Tate	-	-	-	X
	Phos, n.sp.	-	-	X ?	-
	Voluta Hannafordi, McCoy (frag.)	-	X	-	X
	,, ancilloides, Tate	-	X	X	X
	,, McCoyii, T. Woods	? X	X	-	X
	,, cathedralis ? Tate	-	-	-	X
	,, antiscalaris, McCoy	X	X	-	X
	,, strophodon, McCoy	X	X	-	X
	,, n.sp. 1. aff. lirata	? juv.	-	-	-
	,, n.sp. 2.	? juv.	-	X	-
	,, n.sp. 3. aff. n.sp. Muddy Creek	-	-	-	-
†	,, n.sp. 4. aff. conoidea	-	-	-	-
	Lyria harpularia, Tate	X	X	-	X
	Mitra alokiza, T. Woods	X	X	-	X
	,, othone, T. Woods	X	X	-	X
	,, atractoides, Tate	X	-	-	X
	,, n.sp. aff. leptalea	-	-	-	-
	Marginella Woodsii, Tate	-	-	-	X
	,, propinqua, Tate	X	X	X	X
	,, micula, Tate	X	X	X	X
	,, Wentworthi, Tate	X	X	X	X
	,, sub-Wentworthi, Tate	X ? frag.	X	-	-
†	,, sp.	X	X	X	X
	Ancillaria hebera, Hutton	-	-	X	X
	,, semilævis, Tate	X	X	-	X
	,, pseudaustralis, Tate	-	X	-	X
	Columbella clathrata, Tate m.s.	X	X	-	X
†	,, sp.	? X	X	-	-
	,, sp. aff. clathrata	? X	-	-	-
	Cancellaria Etheridgei, Johnston	X	-	X	-
	,, caperata, Tate	X	X	-	-
†	,, n.sp.	X	-	-	-
	Pleurotoma paracantha, T. Woods	X	X	X	X
	,, Claræ, T. Woods	X	X	-	X
	,, sp.	X	X	X	X
	,, sp.	-	-	X	-
	Drillia, sp.	? X	? X	-	X
	Mangilia bidens, T. Woods	X	X	-	X
	,, sp.	-	-	-	X
† ?	,, sp.	-	-	-	-
	Bela sculptilis, ? Tate	-	-	X	X
	,, sp. aff. sculptilis	-	-	-	-
	Raphitoma n.sp.	-	-	-	-
	Pusianella sp. aff. hemiothone	-	-	-	-
	,, n.sp.	-	-	-	-
	Daphnella tenuisculpta, T. Woods	-	X	-	X
	Conus heterospira, Tate	X	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Conus Dennanti, Tate	-	X	X	X
,, n.sp. aff. heterospira	-	-	-	-
Cypræa contusa, McCoy	-	X	-	X
,, pyrulata (?), Tate	-	X	-	X
,, brachypyga, Tate	X	X	-	X
,, leptorhyncha, McCoy	-	X	X	X
,, Mulderi, Tate	X	-	-	-
Trivia avellanoides, McCoy	X	X	X	X
† Semicassis transenna, Tate	-	X	-	X
Cassidaria gradata, Tate	-	X	-	X
Natica Hamiltonensis, T. Woods	X	X	-	X
,, polita, T. Woods	X	X	-	X
Crepidula sp.	-	X	-	-
† ? Scalaria sp.	-	-	-	-
Turritella Murrayana, Tate	X	X	-	X
,, sp.	X	X	X	X
,, sp.	X	X	-	X
,, sp.	X	-	X	-
Siliquaria squamulifera, Tate m.s.	X	X	-	X
Vermetus conohelix, T. Woods	X	X	X	X
,, sp.	X	X	-	-
Eulima sp.	? X	-	-	-
Niso psila, T. Woods	X	X	-	X
Odostomia sp.	X	-	-	-
,, sp.	X	-	-	-
Cerithium crebarioides, T. Woods	X	X	X	X
,, n.sp. aff. crebarioides	-	-	-	-
† Cerithiopsis n.sp.	X	-	-	-
,, n. sp.	-	-	-	-
Triforis Wilkinsoni, T. Woods	X	X	-	X
,, sp.	-	X	-	X
? Calliostoma sp.	-	-	-	? X
Delphinula aster, T. Woods	X	X	-	X
Fissurellidæa malleata, Tate	-	X	-	X
Hemitoma occlusa, Tate, m.s.	X	X	-	X
Emarginula cymbium, Tate, m.s.	-	X	-	X
† Scaphander fragilis, Tate, m.s.	X	X	-	X
† Ringicula sp.	X	X	-	X
Cylichna exigua, T. Woods	X	X	X	X
Class, Scaphopoda.				
Entalis Mantelli, Zittel	X	X	X	X
,, subfissura, Tate	X	X	X	X
Dentalium aratum, Tate	-	X	X	X
Class Cephalopoda.				
Nautilus sp. 1.	-	X	-	-
Nautilus sp. 2.=Gellibrand R. species	-	-	-	X
Class Pisces.				
† Otoliths	X	X	X	X

SUMMARY FOR LOCALITY 2.

Class.	No. of Species.
Actinozoa - - -	3
Echinodermata - -	1
Palliobranchiata - -	1
Lamellibranchiata - -	25
Gastropoda - - -	102
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	137

The following are the only previous records we have seen of fossils from this locality.

Prod. Pal. Vic., Dec. I., p. 28—*Voluta antiscalaris*, McCoy, recorded as "Common in the Tertiary Clays of A^{d}: 14, parish of Moolap."

Id. Dec. III., p. 38—*Trivia avellanoides*, McCoy "very rare and of small size in blue clay (A^{d}: 14) Outer Geelong Harbour."

Id. Dec. IV., p. 14—*Pecten Yahlensis*, T. Woods, "of large size A^{d}: 12;" also *id.*, p. 26—*Voluta strophodon*, McCoy, "Abundant in blue Oligocene Tertiary Clays of Moolap (A^{d}: 14)."

Id. Dec. VI., p. 40—*Lovenia Forbesi*, Duncan, "from Miocene beds of beach at Outer Geelong Harbour, (A^{d}: 12)."

Taking only the Mollusca proper from the two localities we have recorded 150 species distributed as follows:—

Class.	No. of Species.
Lamellibranchiata - -	25
Additional Lamellibranchiata from Locality 1. - -	8
Gastropoda - - -	102
Additional Gastropoda from Locality 1. - -	10
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	150

Of these 150 species only three are represented in living-creation, which, therefore, gives us only two per cent. of living species. Several of the species however have not yet received specific names, but so far as the study of them has gone up to the present, it does not seem possible to refer any of them to living species.

By an inspection of the above list it will be seen to include many of our most characteristic Eocene fossils, and from the accompanying table the close relationship to other characteristic Eocene localities is obvious.

The fossils throughout the dark clays are in a very good state of preservation though the clays are very wet, and this which much increases their tenaceous character also greatly increases the difficulty in procuring specimens without damage, and it is of very little use to attempt to clean the specimens for purposes of identification until they have dried considerably.

A few remarks on some of the fossils might not be out of place. Two of the species namely, *Waldheimia divaricata*, and *Peristernia Morundiana*, have hitherto only been obtained from the River Murray Cliffs, and it is a very interesting fact to find them also in this locality. There can be no doubt whatever about these identifications, as they have been carefully compared with actual specimens from the typical locality.

Pecten dichotomalis is an interesting shell which is at present only recorded from Schnapper Point and the Gellibrand River and is not particularly common at either of these localities.

A new *Fusus* should be noted, examples of which have also been obtained from Schnapper Point. This remarkable shell will no doubt form the type of a sub-genus as it possesses such marked characters of its own, the whorls are wholly disjoined, the canal is almost closed, and the whole shell roughly speaking is somewhat like the columella of some fusoid shell divested of the whorls, the embryonic whorls are however in contact and are terminated by a projecting apex.

Some specimens of a new species of *Phos* were obtained which show strong affinities to the undescribed species occurring at Spring Creek, but owing to the fact that the Spring Creek examples are not in a very good condition nothing very definite about their identity can be said at present. The new species of

Voluta are worth mention. The first is a shell of the type of *V. lirata*, Johnston, but it differs from this species in many points, amongst others the absence of costæ is conspicuous.

The second shell is identical with a new species occurring at Spring Creek, which, in the adult form is quite seven inches in length with a characteristic long and slender spire terminated by an embryo with a markedly exsert tip.

The third, though an incomplete example, shows sufficient characters to designate it a new species with certain affinities to an undescribed species from Muddy Creek, which is related to *V. Stephensi*, Johnston, of Table Cape.

The fourth species belongs to the sub-genus *Volutoconus* and has its nearest ally in *V. conoidea*, but it is readily distinguishable from this species as the spire is much shorter and the whorls more tumid.

Cypræa Mulderi, Tate, is a shell we were not at all sorry to see turn up, as the only two examples previously found were obtained in sinking a deep well in Belmont. The type specimen is in the Adelaide University Museum and the second one is the property of Mr. Mulder of Geelong. Two additional examples were obtained.

A small and very pretty undescribed species of *Nautilus* turned up, which is apparently identical with the one occurring at the Gellibrand River and Muddy Creek.

The amount of disturbance in eocene strata as shown here is apparently unparalleled in Southern Australia and is evidently merely local. The polyzoal rock in M'Cann's quarry at Waurn Ponds dips S. 10° E. at 3° or 4°. The sandy limestones at Belmont, on the river bank just above Barwon bridge, dip E. 40° S. 10°. While between these two localities in the bed of the Waurn Ponds Creek, about 300 yards below where the Geelong to Colac road crosses it, the dip is N. 25° W. 7°. The Muddy Creek beds are stated by Mr. J. Dennant* to be horizontal, while Professor Tate, speaking generally of the Older Tertiaries of Southern Australia, says† that "for the most part secular elevation of the Older Tertiary sea bed has been of small amount and uniform."

* Trans. Roy. Soc. S.A., 1888, p. 33. † Proc. Roy. Soc. N.S.W., 1888, p. 241.

An instance of a high dip in older tertiary strata is however recently quoted by Mr. T. S. Hart* as occurring on the cliff-section near Mentone, and is given as S. 20° E. at 30°, with fractures and slight faulting. The rest of the section shows a very low dip, this high angle being noted in one fold only.

The high dip, contortion and the changed character of the small area of polyzoal rock exposed, point to subsequent volcanic disturbance, though no trace of igneous rock overlying the fossiliferous strata was found. Possibly no great discharge of solid material took place, but heated gases caused the slight metamorphism of the limestones.

The Clifton Mineral Springs, plentifully charged with carbonic acid gas, possibly represent the dying, or solfatara stage, of this outburst.

To the westward of the Curlewis section, the Bellarine Hills rapidly drop to the level of the plain, that separates them from the Geelong Hills, and the eocenes disappear from view. The upper tertiary beds are very thick and apparently form the greater part of the cliffs about the west end of the section, as the gully exposures gave no indication of the existence of any of the older beds, but showed mottled clays sands and conglomerates, and were, as far as we saw, unfossiliferous.

As almost the whole of the visible portion of the eocene beds of this section is exposed only between tide marks, advantage must be taken of low-tides to thoroughly examine the deposit, and this materially shortens the time available for work; besides which, only small portions of shells are visible above the surface as the pebbles and pyrites nodules soon destroy the projecting portions of the fossils. The clay beds, as at Mornington, are inhabited by great numbers of *Barnea australasiae* and *B. similis*. One peculiar feature of the beach is the manner in which the seaweed and shells are consolidated into a peaty mass, the pieces of wood enclosed looking like lignite.

A note on the ¼ sheet (23 S.W.) states that a shaft to the east of Fenwick's Gully showed 61 feet of ferruginous sands and clays overlying seven feet of black sandy clay with nodules of pyrites and fragments of lignite. This latter is called 'miocene,' presumably

* Vict. Nat., vol. ix., p. 157.

as it was thought to resemble the other plant beds of the colony which are ascribed to that age. Now these plant beds at Flemington, Berwick, Dargo High Plains and other places* where they are associated with the Older Volcanic rock, underlie it. However there are certainly good grounds for doubting the age ascribed to the volcanic rock. At Flinders, a small patch of polyzoal rock lies on the deeply eroded surface of the igneous series. The limestone being crowded with foraminifera such as Amphistegina (very common) Operculina and Orbitoides shows an approach in character to the Orbitoides limestone which we showed† lay at the base of the Moorabool Valley beds. At Eagle's Nest, near Airey's Inlet, the so called miocene also, as shown by the sections of the Survey, overlies the volcanic rock. Palæontological evidence is gradually accumulating to show that the ferruginous beds of Royal Park, near Melbourne, also belong to the eocene series, and these beds, as the cutting, for instance, in the park shows, lie also on the deeply eroded surface of the volcanic rock. Here at Curlewis, we show the same sequence. Selwyn‡ says that "the products of both volcanic periods are often contemporaneous, and interstratified, with the marine limestones." The only specific instances we can find quoted of this intercalation, in reference to the Older Volcanic, are the Maude sections on the Moorabool River, and Sutherland's Creek. As a rule then, there has been a considerable lapse of time between the volcanic flows and the deposition of the marine eocene beds. Should the Survey reading of the Maude section prove the correct one, some subdivision of the Older Volcanic series will be required, as a rock, the surface of which is deeply eroded before being covered with a marine deposit, can hardly be ascribed to the same age as a sheet intercalated with the latter. That the officers of the Survey have felt the need of some such division is shown by the legend attached to the older volcanic rock of the Bellarine Hills ($\frac{1}{4}$ sheets 23 N.E. and 23 S.E.) namely 'miocene or older.' That it certainly is older is shown by the fact that the clays which are marked as miocene on the map, but which were subsequently stated by Prof. McCoy to be Oligocene,§ distinctly overlie it. The lower tertiary beds of this

* Murray, Geol. and Phys. Geog. of Vict., p. 104, et seg.

† Proc. Roy. Soc. Vict., vol. iv., N.S., p. 11.

‡ Exhib. Essays, 1866, p. 31. § Prod. Pal. Vic., Dec. iv., p. 26.

area are clearly of the same age as the typical eocenes of Muddy Creek. The plant beds then must come in, either at the base of the eocene series, or may possibly be even of cretaceous age.

Professor Tate has already indicated his discovery in South Australia of beds containing plant remains, which were orginally referred to Miocene age, occurring in conjunction with marine Cretaceous fossils, giving us a somewhat parallel case to the famous Laramie Beds of North America. In the vicinity of Adelaide, beds containing carbonaceous matter are also known to occur directly underlying the Eocene Tertiary as proved by the Adelaide bore.

Plant beds are extensively developed in New South Wales, and Wilkinson* states that they show "a perfect resemblance to the Lower Miocene leaf beds of Bacchus Marsh in Victoria; some of the impressions in the form seem to be undistinguishable from the Victorian fossils." Some of the New South Wales plant beds have been referred by Baron von Ettingshausen† to eocene age, apparently solely based upon the plant remains themselves. The discussions on the age of the New South Wales coal series and of the Laramie Beds of North America, go to show that very little weight can be attached to the evidence afforded by terrestrial or freshwater forms of life. The evidence which has been obtained in South Australia and Victoria is of a more definite nature, and at present seems to point to the Cretaceous age of the older deposits containing plant remains.

From Clifton Springs to Lake Connewarre, the surface is covered everywhere with a thick mantle of Upper Tertiary rocks, consisting of clays, loose sands and quartz gravels. Along the lake margin, and extending some distance inland, ferruginous grits are the almost universal representatives of these beds. They are of a dark-brown hue, coarse grained, fairly hard, and afford the common road metal of the southern part of the district, About a mile N.E. of Drysdale occurs a coarse sandstone with a siliceous cement which is used as road metal near Portarlington. The quartz is glassy and in some cases shows crystalline faces. The rock is of a whitish colour, somewhat cavernous, the cavities being sometimes coated with limonite.

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* Notes on the Geology of N.S.W., 1882, p. 56.

† Mem. Geo. Surv. N.S.W., Pal. No. 2. Contributions to the Tertiary Flora of Australia, 1888, p. 7.

From near the place at which the Barwon enters the lake, to the south end of Kissing Point, which is the Southern termination of Leopold Hill, basalt flanks the hill but does not rise much above the level of the lake. It is clearly a severed portion of the flow forming the plain to the south and west on the southern side of the lake. At Barwon Heads, the same rock is seen to be overlain by the Dune limestone of Mount Colite, and is referred on the $\frac{1}{4}$ sheet to Mount Duneed.

At the south end of Kissing Point, and overlying the basalt, occurs a bed of shells consisting of large oysters and *Barbatia trapezia.* It is about 20 feet above the lake level and is possibly a native shell-mound.

The great mass of the hill at this point is formed of a peculiar sandy limestone, in which no identifiable fossils could be detected. The officers of the Survey, in default of fossils, refer it doubtfully to miocene age. In appearance it somewhat resembles a dune limestone, though as we could not find a good section, we could not detect any false bedding in it. A similiar rock is marked as occurring at Bald Hill across the lake, but we did not visit it. We could not come to any conclusion about the age of this rock, but have not seen any eocene strata which resemble it closely.

From Campbell's Point to the north-west corner of the lake, gray clays constantly appear on the beach floor, and are overlain by yellow earthy limestone just above water level. Apparently the beds do not rise to any height on the cliffs as we saw no exposure anywhere.

Fossils from Point Campbell.

Class, Actinozoa.

Order, Zoantharia.

Balanophyllia Australiensis, Duncan.

Class, Polyzoa.

Numerous genera and species.

Class, Lamellibranchiata.

Ostrea sp.

Dimya dissimilis, Tate.

Nucula Atkinsoni, Johnston.

Limopsis Belcheri, Adams and Reeve.

Pectunculus laticostatus, Quoy and Gaimard.
Cucullæa Corioensis, McCoy.
Crassatella Dennanti, Tate.
Cardita polynema, Tate.
Chione sp. (?)
Corbula ephamilla, Tate.
„ pixidata, Tate.

Class, Gastropoda.

Triton Woodsii, Tate.
Fusus senticosus, Tate.
Fasciolaria exilis, Tate.
Dennantia Ino, T. Woods.
Dolichotoma atractoides, Tate, m.s.
Conus heterospira, Tate.
Cypræa sp. (? platypyga).
Natica polita, T. Woods.
Solarium acutum, T. Woods.
Turritella platyspira, T. Woods.
Vermetus conohelix, T. Woods.
„ sp.
Cerithium crebarioides, T. Woods.

Class, Scaphopoda.

Entalis Mantelli, Zittel.
„ subfissura, Tate.

Class, Pisces.

Otoliths.

FOSSILS FROM POINT CAMPBELL.

SUMMARY.

Class.	No. of Species.
Actinozoa - - -	1
Lamellibranchiata - -	11
Gastropoda - - -	13
Scaphopoda - - -	2
Pisces - - - -	1
Total - - -	28

From here to Fenwick's Gully, only Upper Tertiary beds were seen along the shore. On following up the gully the yellow earthy limestone, which forms the upper portion of the eocenes in the Geelong district, was seen outcropping frequently. It is overlain by a white earthy travertin, which is derived from it, and is burned for lime in the district. To the north of the Queenscliff Road, is a quarry on the side of the gully, which has for many years supplied the road with metal.

The hard rock occurs in narrow irregular bands, varying from a foot to a few inches in thickness. The rest of the deposit consists of yellow earthy limestone of a softer texture. The hard bands are composed of a fawn-coloured, granular, siliceous limestone which rings under the hammer and breaks with a clean sharp fracture. Sir Richard Daintree, who analysed it, states its composition to be as follows*.

Carbonate of lime	75·20
,, ,, magnesia	3·00
Silica	15·79
Alumina and peroxide of iron ...	3·00
	96·99

The following are the fossils obtained from this locality, owing however to the very hard nature of the rock, it is a somewhat difficult matter to collect any number of specimens.

Placotrochus deltoideus, Duncan.
Lovenia Forbesi, Duncan.
Dimya dissimilis, Tate.
Marginella propinqua, Tate.
? Ancillaria sp.
Cypræa sp. (cast probably leptorphyncha).
Turritella sp.

From an inspection of the above list, the horizon to which these rocks belong will be readily recognised as eocene.

Between the mouth of the gully and Ocean Grove the ¼ sheet (29 N.W.) marks a continuous outcrop of lower tertiary strata. Although we followed the margin of the lake between these two

* Selwyn and Ulrich, Ex. Essays, 1866, pp. 35 and 73.